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THE INSTITUTE OF INDUSTRIAL RESEARCH

THE PRESERVATION OF THE EXTERIOR OF WOODEN BUILDINGS

BY

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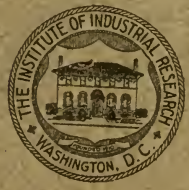

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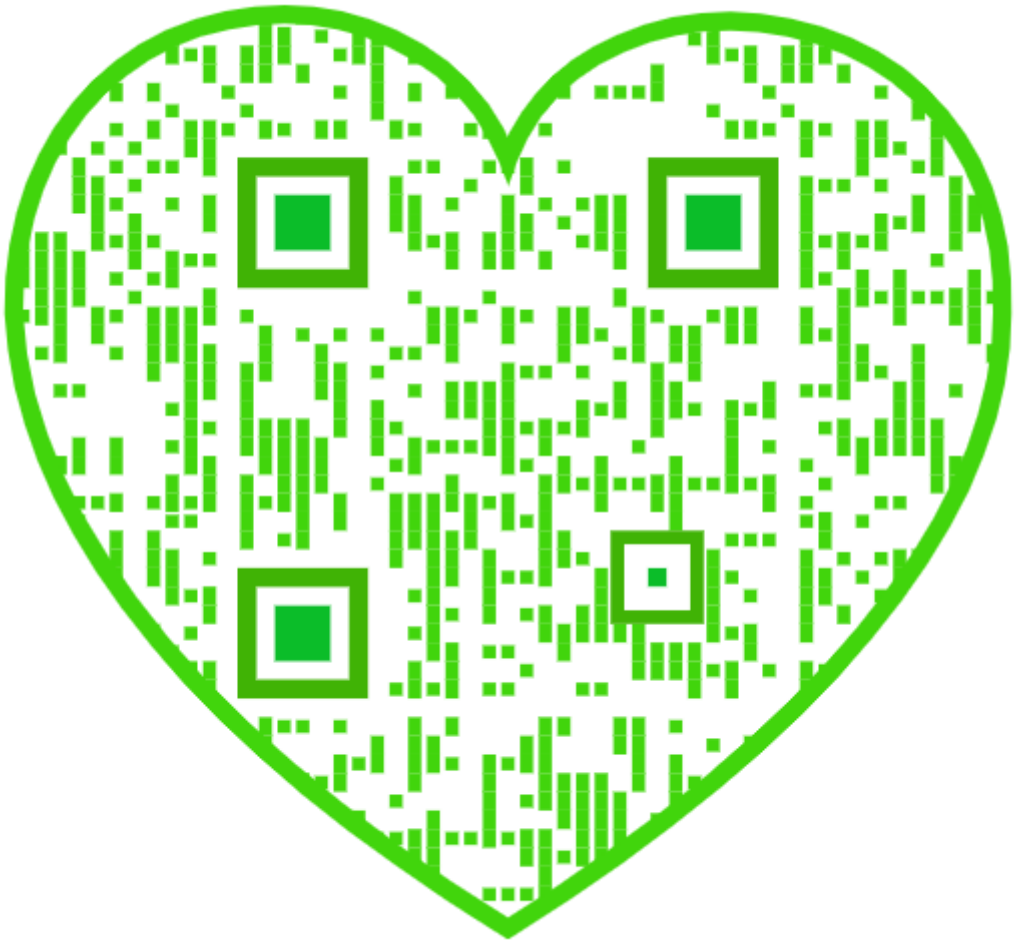

THE INSTITUTE OF INDUSTRIAL RESEARCH

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BULLETIN NO. 1

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PREFACE

FOR a number of years the writers have been making a study of industrial problems and have been publishing the information which they have acquired, regarding the value of various structural materials, for the benefit of consumers as well as producers. The Institute of Industrial Research has received so many requests recently for information in regard to just what paints should be selected for the protection and decoration of houses and other buildings that it has seemed best to sum up the subject in the form of a special pamphlet or bulletin. It is only after years of investigation work carried on by the authors, both separately and in co-operation, that any review of the work has seemed possible, for only recently have the results of tests carried on in a number of different localities seemed to justify a definite opinion in regard to the best selection of exterior paints. No attack on any one paint material is here included, but the value of each has been carefully weighed, and the attempt is

made to discuss them in the light of experience and knowledge. It is the authors' intention in this bulletin to put into the hands of architects and paint-users who may not be thoroughly familiar with the technical properties of paint materials, information which will enable them to make a proper and intelligent selection of paints for the preservation and decoration of the exterior of wooden buildings.

The Preservation of the Exterior of Wooden Buildings

Lumber and its Relation to Paints: The proper choice and treatment of lumber is one of the most important problems which the builder as well as the painter has to face. When about to build a dwelling, barn, or other structure made principally of wood, the question is sure to arise in regard to what variety to select so as to get the maximum service and money value. The locality in which the structure is to be built must often have a bearing upon this question. While it is true that the painting of each type of wood demands the special consideration of the painter, it is also true that the study of paints for wood protection points toward the production of a paint that will give satisfactory results under all conditions and on all grades. It is the writers' opinion that a paint may be made that will be perfectly well suited for the preservation of every species of wood, provided the paint is properly treated in the hands of the skillful and intelligent painter, who can produce lasting results on almost every type, by varying the proportion of thinners and oil in the various coats. The painter who uses the same paint on soft pine,

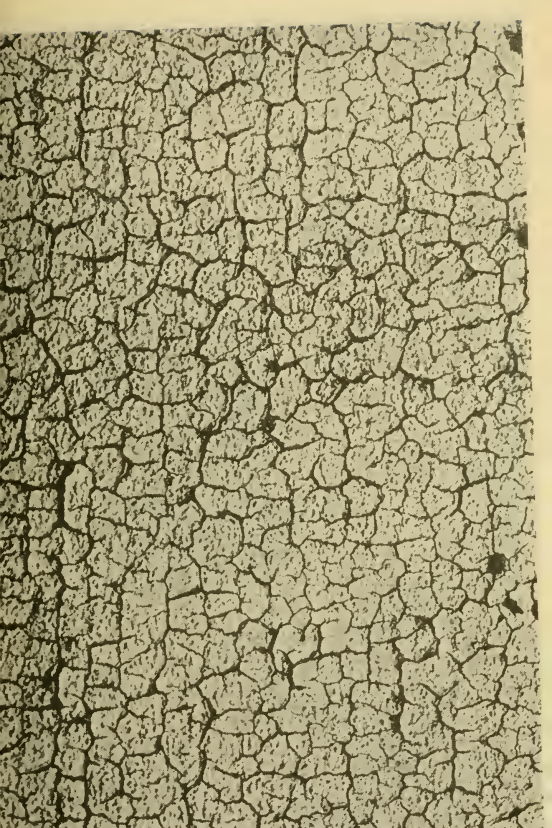
and again on hard pine, without making a special study of how to reduce the priming coat for the hard pine, will be likely to get inferior results on the latter. In case of failure, the natural impulse is often to place the blame upon the paint, whereas the real responsibility may rest upon the painter's lack of knowledge.

Signs of Paint Failure: Those who are responsible for the care and maintenance of property are familiar with the condition of surface presented by almost all wooden buildings or structures which have been improperly painted with inferior paints. "Chalking" or "flouring" are terms used to describe the condition of a paint surface which has deteriorated within the paint film. The formation of minute fissures, generally spoken of as "checking," as well as the effects best described as cracking, scaling, peeling, and blistering, are other signs of failure which cause paint coatings to present an unsightly appearance, and which point inevitably either to the use of improperly made paints or to improper application. The cause of these conditions is not difficult to understand when even a brief study of the character of the materials entering into the composition of a paint has been made. It

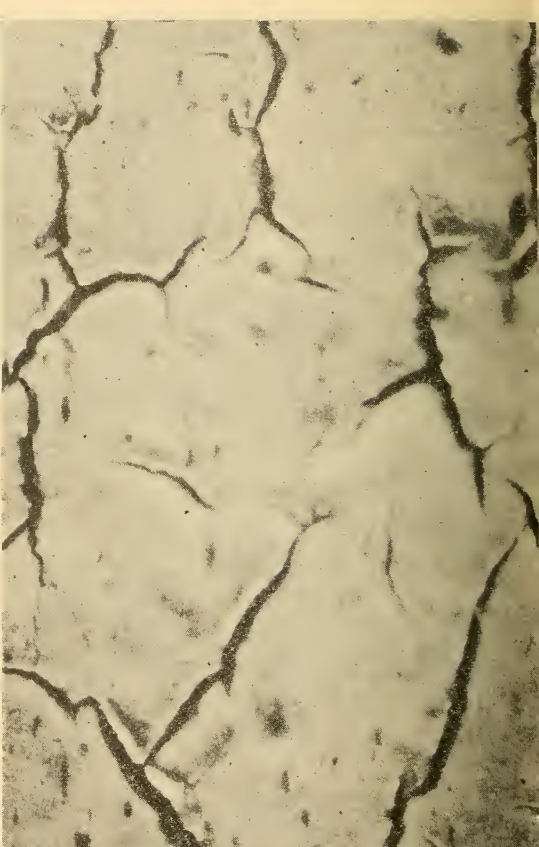
NOTE.—For a more detailed account of the lumber question, see "Modern Lumber as a Problem for the Painter," read by John Dewar, at the Convention of Master House Painters' and Decorators' Association of Pennsylvania, January, 1911, Pittsburg, Pa.

BLISTERING.—Type of Decay Exhibited by Improperly Made Paint (magnified view).

CHALKING.—Type of Decay Exhibited by Improperly Made Paint (magnified view).

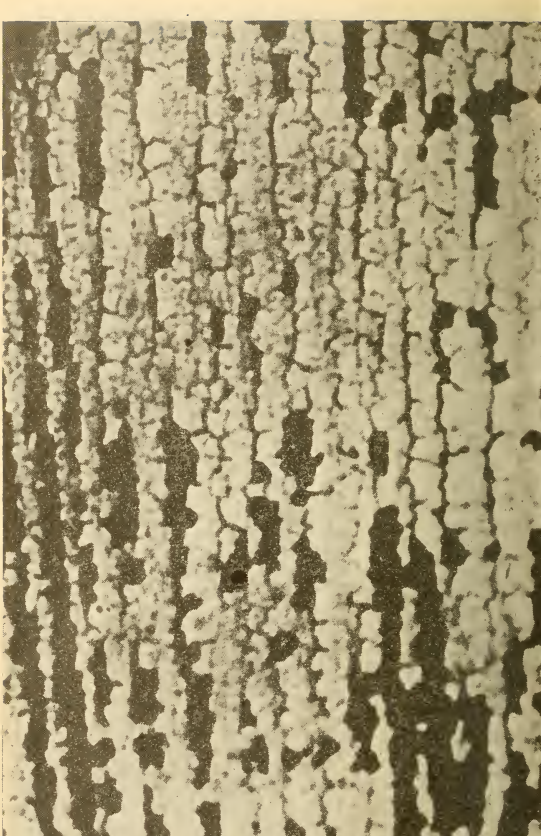


CHECKING.—Type of Decay Exhibited by Improperly Made Paint (magnified view).



CRACKING.—Type of Decay Exhibited by Improperly Made Paint (magnified view).

SCALING.—Type of Decay Exhibited by Improperly Made Paint (magnified view).



GENERAL DISINTEGRATION.—Type of Decay Exhibited by Improperly Made Paint (magnified view).

is, however, a fortunate circumstance that the proper admixture of different types of pigments enables us to correct the strong tendency exhibited by special pigments to rapidly deteriorate in an oil film. This point will be more fully discussed in a later paragraph.

Requisites of a Good Paint: Progressive manufacturers are aiming to produce a paint which will show, under the widest range of conditions, good hiding power, adhesiveness, freedom from internal strains, permanency of color, relatively high imperviousness to moisture, sufficient elasticity to prevent scaling or cracking when subjected to expansion or contraction, and freedom from the chemical action which results in deep checking or excessive chalking. Such a product as this cannot be attained, in the writers' opinion, by the use of any one pigment in linseed oil. In order to meet all the demands as stated above, there should be in an economical and durable paint a proper percentage of the various pigments which, united, will tend to correct each other's faults, and thus produce a durable paint coating of maximum efficiency.

The Composition of Paints: As is well known, a paint is a mixture of one or more pigments and a vehicle which acts the part of the spreading and binding medium. Up to the present time the vehicle portion of paints has generally been made of linseed oil, admixed with some volatile thinner, such as turpentine.

The subject of oils and paint vehicles will be discussed more fully later on.

Physical Properties of Pigments: The pigment portion of a paint for use on barns and farm buildings may, if desired, be composed of properly selected iron oxides or other colored pigments, even containing in some cases a moderately high percentage of silica, clay, or other inert materials, and give perfectly satisfactory results. For the preservation and decoration of dwellings, however, the pigment portion of paints is generally made as a whole or in part of the more expensive white pigments, such as white lead and zinc oxide. The relative values and properties of these white base pigments will now be taken up.

White Leads: White lead, either of the corroded or sublimed type, is perhaps the most generally used of all the white pigments as a paint base. Corroded white lead is a basic carbonate of lead, while sublimed white lead is a basic sulphate of the same metal. Both of these types are white, and admirably adapted as painting materials. They take relatively the same amount of oil and spread easily, producing paint films which are highly opaque and which, therefore, hide efficiently the surface upon which they are placed. Sublimed white lead is a relatively finer pigment than corroded white lead, and seems to show a tendency to chalk to a greater extent upon exposure to the weather. Corroded white lead is more alkaline, however, than sublimed white lead, and

when used alone with linseed oil generally shows a tendency to chalk to a considerable extent in a short time and to show deep checking, thus permitting the admission of moisture. The alkaline nature of this pigment produces considerable action upon certain tinting colors and results in fading or darkening, when mixed with delicate greens or blues.

The use of white lead has been condemned in some parts of this country, as well as abroad, because of its alleged poisonous properties. While it is true that lead poisoning may occasionally occur in some factories where the workman and his conditions are not properly safeguarded, it is, nevertheless, a fact that lead poisoning very seldom occurs among painters of experience and cleanly habits. Carelessness in mixing white lead is, fortunately, a practice almost obsolete among modern painters. The use of paints already ground in oil by means of machinery to a pasty condition, allowing easy working and reducing, obviates the danger of lead poisoning from any such cause as this, even though the percentage of lead in such paints is in preponderance. Recent efforts that have been made by the legislatures of certain States to brand lead paints as poisonous are not only unnecessary, but show a complete ignorance of the problem.

Zinc Pigments: Another pigment which has proved itself of great value to the

painter is zinc oxide. The use of this pigment may be said to have almost revolutionized the paint industry of the world, and its increased consumption during the last ten years is sufficient evidence of its value as a painting material. Zinc oxide is produced by oxidation and sublimation of zinc ores and is not only extremely fine, but of great whiteness. It has good hiding power, although not quite so great as that shown by the white leads. It tends to produce a glossy surface, making it especially valuable for use on interior work and in enamels. When used alone it has the effect of hardening the oil film in which it is enveloped, and upon long exposure causes cracking and scaling. However, when the sublimed or corroded white leads are properly combined with zinc oxide, a more durable surface is produced, the shortcomings of each pigment being overbalanced by the good properties of the other. The proper combining properties of zinc oxide with white lead may be said to vary between 20 to 55 per cent of zinc oxide for paints designed for exterior use. In the opinion of the authors, lead and zinc pigments in the above percentage, properly blended and ground, make paints of far better wearing value than can be produced with either white lead or zinc oxide used alone.

Zinc Lead: Zinc lead, a pigment sublimed from mixed lead and zinc ores, and containing about equal proportions of zinc oxide and lead sulphate inti-

mately combined, as well as leaded zinc, a product similarly produced, but with the zinc oxide running about 75 per cent, are white base pigments of value, which are used to a considerable extent. They are generally slightly off color, however, and are therefore used most largely in paints which are to be tinted in various colors.

Lithopone: Lithopone, a pigment produced by precipitation, and consisting of zinc sulphide and barium sulphate, is of great value in the manufacture of interior paints. On account of its liability to darken and disintegrate, however, it is seldom used on exterior work, although recent tests have shown that when used in combination with zinc oxide and whiting, it gives very promising results.

Crystalline Pigments and Their Use: Barytes (barium sulphate), silex (silica), whiting (calcium carbonate), gypsum (calcium sulphate), asbestine (silicate of magnesia), and china clay (silicate of alumina) are white crystalline pigments which, when ground in oil, become transparent. All of these pigments possess the property of strengthening a paint film made of white lead and zinc oxide, and often increase the durability of such a paint. Barytes, silica, and china clay are especially valuable for this purpose. Asbestine, because of its needle-like structure and low gravity, prevents settling and acts as a reinforcer of paint films. Whiting or calcium carbonate should be

used when zinc oxide is in excess in a paint, so that the hardness of the paint may be overcome.

A white paint must be possessed of sufficient opacity to efficiently hide the surface upon which it is placed, when three coats are applied for new work or two coats for repainting work. Mixtures of the white leads and zinc oxide, with the latter pigment running not over 55 per cent, will easily produce such a result and wear well. It is generally deemed advisable, however, by most manufacturers to take advantage of the excessive opacity of such mixtures, which allows the introduction of moderate percentages of those inert pigments which give greater strength and other desirable features to a paint. The percentage of natural crystalline inert pigments to add to a white paint made of lead and zinc must, however, be moderate and insufficient to detract materially from the hiding power of the paint.*

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* Pigments such as silica, barytes, china clay, and asbestine are thoroughly inert. Recent investigations have proved that they accelerate the drying of linseed oil, but this is not due to any chemical action they exert, but rather to their physical action in distributing the mass of oil in which they are ground, and thus allowing a greater surface to be exposed to the oxygen of the air.

It is also possible that some of the inert pigments may stimulate oxidation by catalytic or contact action, although they are not chemically active in themselves.

White-Paint Formulas: From these conclusions, which have come from wide experience in the testing of paints under actual service conditions, there can be recommended to the buyer of paints and to the manufacturer and master painter those machine-mixed paints in white, made by reputable manufacturers, the composition of which will show a mixture of white lead and zinc oxide, with the latter pigment within limits of between 15 to 55 per cent, and especially the same mixtures reinforced with the moderate percentage of crystalline inert pigments referred to above.

Tinted paints possess greater hiding power than white paints, and the above proportions would be somewhat changed for a tinted paint containing any percentage of coloring material. Tinted paints are, moreover, far more serviceable than white paints, as will be shown later.

Mill vs. Paddle: The mixtures under consideration should be ground in linseed oil by the manufacturer, through stone or steel mills, to a very fine condition, as it is only through proper grinding that the pigments can be properly blended. The mixing of paint by hand is, fortunately, to a large extent a thing of the past. The uneven lumping of hand-mixed paints is often the cause of their failure. Such ancient and crude practice should be avoided by every painter, for it is more economical to obtain semi-paste paints, properly ground by ma-

chinery, to such a condition that they may be easily broken up and tempered. Such paints may be reduced to the proper consistency with oil and volatile thinner for application to any kind of wood.

In the opinion of the writers, a majority of the paints sold by reputable dealers and made by reputable manufacturers in this country are not only made from the best linseed oil and highest-grade pigments obtainable, but are put up in a form ready for the painter to thin down with full oil or turpentine reductions, either for priming work or to be used without reductions for finishing coats. The large metropolitan painter who wishes to make his own tints and shades may, however, prefer to have his mixed pigment paint ground by the manufacturer in heavy paste form for certain purposes.

Results of Field Tests: A careful analysis of the results of field tests which have been carried on in different parts of the country would be far too voluminous for insertion in this bulletin. The official findings of special committees of inspection have already been published in special reports. Whereas there may still remain ground for some difference of opinion in regard to the interpretation of the results obtained on the various test fences, there can be no doubt that considerable information of the highest value has been yielded, both to the producers and consumers of paints. One of the principal results obtained from these

tests has led to the opinion expressed above by the writers, that better results can be obtained by a proper mixture of selected pigments than by the use of any one pigment in linseed oil. This conclusion has also been reached by engineers of the United States navy, and, as a result, the specifications of the Bureau of Yards and Docks for paints made of straight white lead and oil have recently been changed to call for white lead combined with upwards of 50 per cent of zinc oxide. Many engineers and master painters have interpreted the results of the tests in the same way, and the attention of the authors has been called to a number of opinions which show that the tendency of demand among those who are properly informed is for a high-grade combination type of paint rather than for any single pigment paint.

Color: The selection of the color for a dwelling or other structure is a matter that depends largely upon the good judgment and taste of the owner, combined with the advice of the painter. One point, however, should be impressed upon the mind of both, namely, that PRACTICALLY ALL SHADES OR TINTS MADE UPON A GOOD WHITE PAINT BASE, THROUGH THE USE OF PERMANENT TINTING COLORS, WILL BETTER WITHSTAND EXPOSURE TO THE ATMOSPHERE THAN THE WHITE BASE USED ALONE. Owing to the cheerful effect produced by the use of white paint on dwellings, a very large quantity of white will continue to

be used. If these white paints are designed in line with the suggestions brought out above—that is to say, if the white lead bases are properly reinforced with zinc oxide and other pigmentary materials—better results will undoubtedly be obtained, as far as appearance and durability is concerned, than if white lead had been used alone. The consumer should remember, however, that more durable results will be obtained by the use of tinted paints.

Reductions and Thinners: Turpentine, with its sweet odor, high solvent action, and wonderful oxidizing value, has always taken first place among the volatile liquids used for thinning paints. Wood turpentines, produced from the steam distillation of fine-cut fat pinewood or from the destructive distillation of stumpage and sawdust, have been refined in some cases, by elimination of odor and toxic effects, to such purity that they are equally as good as the purest grades of gum turpentine, and their use is bound to increase in the paint industry.

The painter and manufacturer have come to understand that certain grades of asphaltum and paraffine distillates are equally as satisfactory as turpentine for use in paints for exterior purposes. Those volatile oils which are distilled from crude oil with either a paraffine or asphaltum base and possessed of boiling point, flash point, color, and evaporative value approximating similar constants of turpentine, are excellently suited to

partly, and in some cases wholly, replace turpentine in exterior paints. A little additional drier added to paints thinned with these materials will cause oxidation to take place in the proper time.

Prominent master painters* have shown that benzol, a product obtained from the distillation of coal tar, differing from benzine, a product obtained from the distillation of petroleum, is a valuable thinner to use in the reduction of paints for the priming of resinous lumber such as cypress and yellow pitch pine. The penetrating and solvent value of benzol is high, and it often furnishes a unison between paint and wood that is a prime foundation to subsequent coatings, preventing the usual scaling and sap exudations, which often appear on a painted surface. Because of the great solvent action of benzol, however, this material should never be used in the second and third coatings. These facts will doubtless interest the Southern painter, who has so much wood of a refractory nature to paint.

Oils: The increasing cost of linseed oil has raised the interesting question as to whether or not it is good practice to use an admixture of other oils in connection with it, in high-grade paint coatings. Strong differences of opinion will probably be found in regard to this question, and undoubtedly further investigation work is necessary in order to decide

* Dewar, Titzel *et al.*

it. A number of different oils have been proposed for the purpose, of which, perhaps, soya-bean oil is the one which has been most prominently discussed. No definite formulas, however, should be recommended until the results of investigations which are now being carried on are in hand. A systematic series of test panels is now being erected in Washington, D. C., on the grounds of The Institute of Industrial Research, which are designed to gather data covering just this point.

The flax crop conditions have been most discouraging during the past two years, and the natural shortage of seed has caused a rise in the price of linseed oil, which has necessitated a rise in the price of paint. The added protection to be secured, however, through the frequent application of paint far outweighs any increased cost which has been caused by the rise in price of the raw commodities entering into the composition of paint.